2010-05-13

Improving Defense Acquisition Processes with Evidenced-Based Analysis: An illustrative case using the DOD SBIR program

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Generic Program Analysis Limiting Factors

- Over reliance on survey response for evaluation
- Program outcomes difficult to quantify

Response Bias

- Lack of reliable data on participants
- Lack of an appropriate control group
- Evaluation performed after-the-fact of selection
- Selection into program non-random

Selection Bias

Why Should Defense Acquisition Policy Makers Care About Program Evaluation?

- Government Performance and Results Act has required evidence-based policy analysis since 1993.

- GAO's 2010 high risk watch list finds DOD's program management processes "lacked basic information, such as identifying specific business areas and key elements, such as goals, objectives, and performance measures."

There is evidence that we are not complying with the intent of spirit of the law

Why is evaluating the DOD's Small Business Innovation Research Program Important?

- DOD SBIR program represents 2.5% of R&D budget, currently over $1.2B
- DOD SBIR program represents about 50% of federal SBIR program
- SBIR funding has been found by analysts, and researchers to displace private venture capital investment. (Wallsten, 2000; Branscomb, 2002)

What is the SBIR Program?

- Mandatory set-aside program for 11 federal agencies with significant extramural R&D budgets.

- Three stage program to transition small business research from ideas to commercial market.

- DOD SBIR program:
  - 3-4 solicitation a year
  - 1000 topics with about 12 proposal per topic
  - Award about 2 contracts per topic

Why Should Defense Acquisition Managers Care About Evaluating SBIR?

- Its required by SBIR legislation and GPRA.
- GAO & OMB find that DOD's evaluations of the SBIR program is inadequate. (GAO, 2005; OMB, 2005)
- SBIR costs the DOD valuable resources.
- No one knows the effectiveness of the program.

How can the SBIR Program Evaluation Overcome Biases?

- Control response bias by using non-survey data such as contract awards
- Control for selection bias by using one of the following methods prescribed by evidence based standards:
  - Conduct experiments with randomized controlled trials

    -OR-

  - Use quasi-experimental methods that mimic RCT when conditions permit:
    - Thousands of treatment and control observations
    - Detailed information on all observations

SBIR meets all quasi-experimental requirements and DOD collects all contract award data

An Example Of Biased Estimates

- National Academies of Science survey of SBIR award winners reports that the average firm commercializes $1.3M per topic. (NAS, 2007)
  - Response Bias
- I estimate that 2003 winners receive $447K more non-SBIR defense contracts compared to a set of firms that applied for but were no awarded a 2003 SBIR contract. (Edison, 2010)
  - Selection Bias

Naïve Differences in Differences

Then year $K

Group/Year	2003	2004	Δ04-03
Winners	1,430	2,081	650
Losers	456	659	203
ΔW-L	975	1,422	**$447K**

Population Size

- Population source: 2003 and 2004 DOD SBIR applications, linked to DD350 database

	Control	Treated
All	773	687
Matched	681	534
Unmatched	92	153
Discarded	0	0

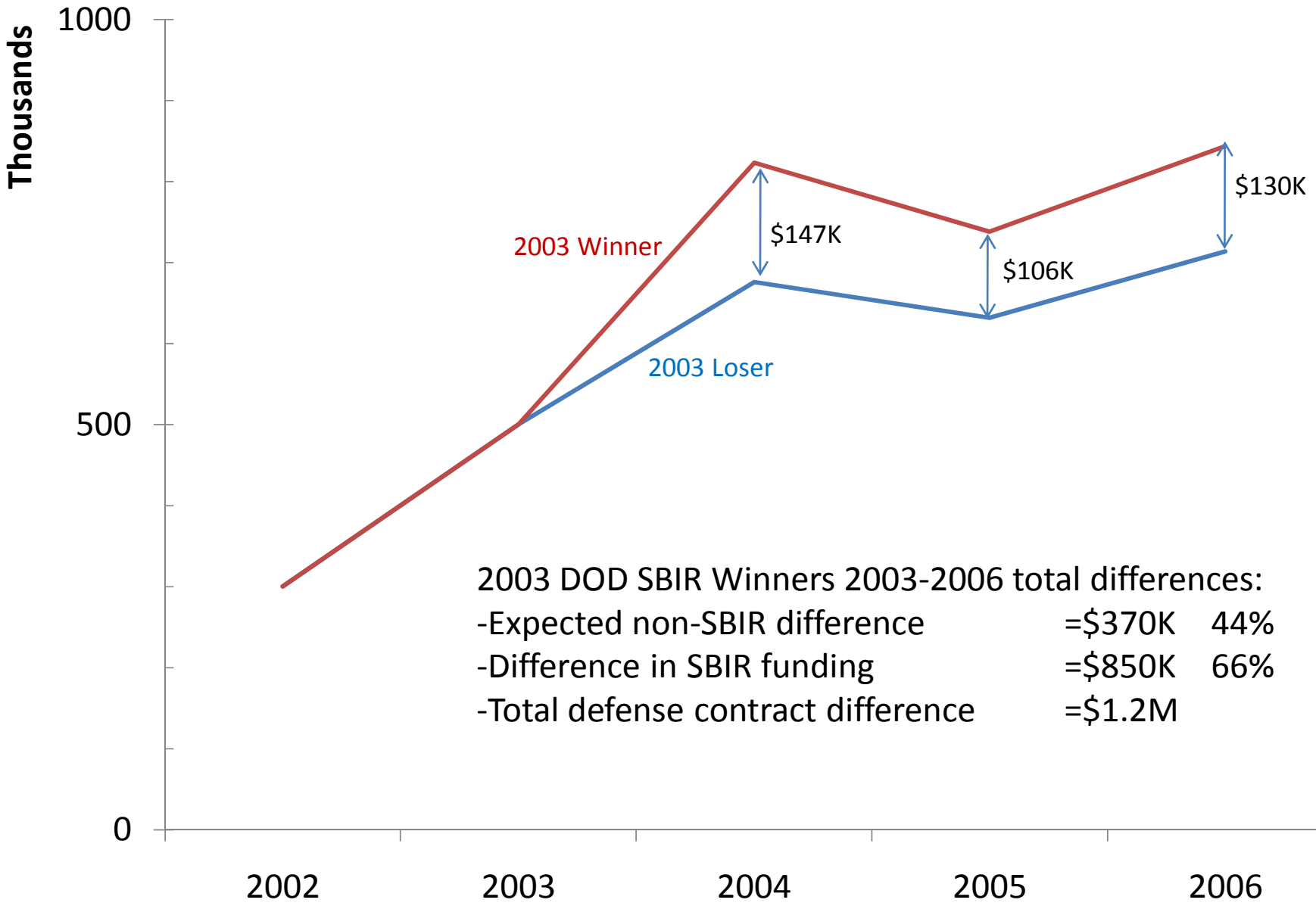
A Primer on How to Control for Selection Bias

- Randomized Controlled Trial
  - Selection to treatment is random
  - Thus treatment and control group should be identical
  - $\Delta Y = Y_t - Y_c$

- Quasi-experiment
  - Selection non-random. Either Y_t or Y_c unobservable
  - Solution: use statistics to find a close match for Y_t

Doubly Robust Estimate of DOD SBIR Average Treatment Effect

- **Data:** 2003 SBIR coversheet data matched to defense contract award data base 1450 pre-matched observations, 773 losers, 687 winners
- **Method:** Doubly Robust Estimation
  - First match treatment to control group with propensity score matching using coarsened exact matching method
  - Estimate treatment effect using regression with controls
- **Treatment identification:** 1=win any 2003 SBIR award
- **Key outcome of interest:** total non-SBIR future defense contract dollars awarded 2004-2006
- **Control variables:** 2002 non-SBIR contract $, 2003 employees, first DOD contract year, subcontact status in 2003, total past SBIR awards, total topics applied for in 2003, and a dummy for past reported commercializaion
- **Response bias mitigation:** administratively collected defense contract awards, not survey responses
- **Selection bias mitigation:** Closest matching firms from control group of applications who did not win in 2003



2003 DOD SBIR Winners 2003-2006 total differences:

-Expected non-SBIR difference	=$370K	44%
-Difference in SBIR funding	=$850K	66%
-Total defense contract difference	=$1.2M	

Is DOD SBIR Program Effective?

- Yes
  - Quasi-experimental evidence supports conclusion that winning a DOD SBIR award increases future non-SBIR contracts.

- However, differences in future non-SBIR contracts is modest:
  - Only 44% of total defense contract portfolio is not SBIR
  - Less than $150K per year per firm treatment effect on average

Conclusion

- There is evidence that for some DOD acquisition programs that evidenced-based analysis is possible
- DOD SBIR program is ideally suited to evidenced based analysis
- DOD SBIR program appears to be increasing future non-SBIR contracts for winners.

Recommendations

- Implement RCT aspects into SBIR program.
- Create more automated links to research output.
  - eg. Patents, income, technical publications
- Use evidence-based analysis to improve program administration.

Next Steps

- Dozens (perhaps hundreds) more studies are needed on the DOD SBIR program.
- A randomized controlled trial is feasible on the DOD SBIR program and should be seriously considered.
- Other Defense Acquisition policy might be suited for this type of evidence based analysis